WEST VIRGINIA DEPARTMENT OF TRANSPORTATION

Division of Highways

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Byrd E. White, III
Secretary of Transportation/
Commissioner of Highways

Jimmy Wriston, P. E.
Deputy Secretary/
Deputy Commissioner

June 22, 2020

Mr. Dale Hill
Executive Director
Builders Supply Association
400 Allen Drive, Suite 50
Charleston, West Virginia 25302

Dear Mr. Hill:

Requirements for Aggregates Suppliers that Provide Aggregate for Concrete Mix

A proposed Specification change in Section 601.3.1.1 pertaining to concrete mix designs that contain potentially reactive aggregates, and more specifically Aggregate Suppliers that provide aggregates for concrete mixes, will be implemented in the 2021 Specifications, pending approval by the Specification Committee in 2020. Aggregates are considered to be reactive based on the results of testing pertaining to Alkali-Silica reaction. The proposed Specification change gives Aggregate Suppliers an option to have their aggregates tested and states: "Aggregate Suppliers may have their fine aggregate and coarse aggregate tested in accordance with ASTM C1293 at a Division approved lab (an AASHTO accredited Lab, accredited for ASTM C1293) at the Aggregate Supplier's expense. The sampling and shipping of all aggregate shall be witnessed by a representative of the Division. Aggregate Suppliers may also submit results of ASTM C1293 tests which were performed by another State DOT lab. The results of ASTM C1293 testing and the resulting determination of the reactivity class of aggregate shall supersede the reactivity class of aggregate, as determined by the Division, when tested in accordance with AASHTO T 303. ASTM C1293 test will be considered valid for 5 years from the date of testing".

This letter is being sent out to clarify what is required from those Aggregates Suppliers who are planning to have their fine aggregate and coarse aggregate tested in accordance with ASTM C1293 as mention in the proposed Specification. The requirements are as follows:

- **Written notification to MCS&T Division by July 8, 2020 if Aggregate Suppliers are planning to have their fine aggregate and coarse aggregate tested in accordance with ASTM C1293 as mention in the proposed Specification.**
- **Arrange/Schedule a date by July 22, 2020 for the witnessing, by a representative of MCS&T Division, of the sampling and shipping of the subject aggregate(s).**

The expiration date of concrete mix designs which are currently approved, and that expire in 2021, and which contain an aggregate that is in the process of ASTM C1293 testing, will be extended until December 31, 2021.

As noted in the proposed Specification, if Aggregate Suppliers are going to submit results of ASTM C1293 tests which were performed by another State DOT lab, those results must be submitted to MCS&T Division by September 15, 2020.

Aggregate Sources, which are in the process of ASTM C1293 testing will be considered "Non-Reactive" (R0) until December 31, 2021, but any concrete mix designs that are approved until that time and contain an Aggregate Source which had been tested in accordance with ASTM C1293 will expire after one year from the date of approval. Subject concrete mix designs will be extended for an additional two years if either of the following criteria are met:

i. **The Reactivity Level of the subject aggregate, as determined by ASTM C1293 testing, is "Non-Reactive" (R0).**
ii. **The mix designs comply with proposed Specification change in Section 601.3.1.1 when the Reactivity Level of the subject aggregate, as determined by ASTM C1293 testing, is anything other than "Non-Reactive" (R0).**

Should you have any questions or require additional information, feel free to contact Mr. Suman Thapa, of this Division, at (304) 414-6662.

Very truly yours,

DocuSigned by:
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Ronald L. Stanevich, P.E.
Director
Materials Control, Soils and Testing Division

RLS:Mte

April 30, 2020

WEST VIRGINIA DEPARTMENT OF TRANSPORTATION

DIVISION OF HIGHWAYS

SUPPLEMENTAL SPECIFICATION

FOR
SECTION 601
STRUCTURAL CONCRETE

601.3.1-MIX DESIGN REQUIREMENTS:

ADD THE FOLLOWING SUBSECTION:

601.3.1.1-Mix Design Using Potentially Reactive Aggregate: Alkali-Silica Reaction (ASR) is a reaction between the alkali hydroxide in concrete pore solution and reactive forms of silica in the aggregate. The reaction forms a gel that swells when moisture is present and may cause deleterious expansion within the concrete.

The Division will sample aggregate according to MP 700.00.01 and test fine aggregate and coarse aggregate in accordance with AASHTO T 303 to determine the reactivity class of aggregate. The reactivity class for each aggregate source will be listed on the MCS&T web page under Division Approved Source/Product Listing (APL) for aggregate. If the reactivity class of an aggregate Source is not listed on the APL, the Division will test fine and coarse aggregate from the Source, in accordance with AASHTO T 303, to determine the reactivity class of the aggregate prior to its use on any WVDOH project. If one or both of the aggregates (coarse or fine) used in a concrete mix are reactive (R1, R2 or R3), preventive measures are required as specified in section 601.3.1.1.1.4. The Division will test Aggregate Sources on a 3-year cycle in accordance with AASHTO T 303.

Aggregate Suppliers may have their fine aggregate and coarse aggregate tested in accordance with ASTM C1293 at a Division approved lab (an AASHTO accredited Lab, accredited for ASTM C1293) at the Aggregate Supplier's expense. The sampling and shipping of all aggregate shall be witnessed by a representative of the Division. Aggregate Suppliers may also submit results of ASTM C1293 tests which were performed by another State DOT lab. The results of ASTM C1293 testing and the resulting determination of the reactivity class of aggregate shall supersede the reactivity class of aggregate, as determined by the Division, when tested in accordance with AASHTO T 303. ASTM C1293 test will considered valid for 5 years from the date of testing.

This requirement applies to all permanent concrete structures on WVDOH projects.

601.3.1.1.1-Selecting Preventive Measures For ASR: The level of prevention shall be determined by considering the classes of concrete, precast concrete member, prestressed concrete member, the degree of aggregate reactivity and the level of alkalis from the Portland cement. The different levels of prevention are shown in Table 601.3.1.1.1.3.

601.3.1.1.1.1-Aggregate Reactivity: The degree of ASR reactivity of an aggregate will be determined as outlined in 601.3.1.1. Aggregate-reactivity classes are given in Table 601.3.1.1.1.1

If the coarse and fine aggregates in a mix design are of different reactivity classes, the level of prevention shall be selected for the most reactive aggregate type in the mix.

Table 601.3.1.1.1.1
Classification of Aggregate Reactivity

Aggregate-Reactivity Class	Description of Aggregate Reactivity	14-Day Expansion when tested in accordance with AASHTO T 303, %
R0	Non-Reactive	≤0.10
R1	Moderately Reactive	>0.10 to ≤0.30
R2	Highly Reactive	>0.30 to ≤0.45
R3	Very Highly Reactive	>0.45

601.3.1.1.1.2-Level of ASR Risk: Determine the level of ASR risk occurring in a structure by considering the aggregate reactivity class in Table 601.3.1.1.1.2.

Table 601.3.1.1.1.2

Aggregate-Reactivity Class	R0	R1	R2	R3
Level of ASR Risk	Risk Level 0	Risk Level 1	Risk Level 2	Risk Level 3

601.3.1.1.1.3-Level of Prevention: The level of prevention required is determined from Table 601.3.1.1.1.3 by considering the risk of ASR from Table 601.3.1.1.1.2 in different classes of concrete, precast concrete member and prestressed concrete member (Section 603).

Table 601.3.1.1.1.3
Determining the Level of Prevention

Level of ASR Risk	Classes of Concrete		Precast Concrete Member	Prestressed Concrete Member
	D	A, B, C, K, H, DC		
Risk Level 0	V	V		V
Risk Level 1	~~X~~ W	~~Y~~ X		~~Z~~ Y
Risk Level 2	~~Y~~ X	~~Z~~ Y		~~See footnote**~~ Z
Risk Level 3	~~Z~~ Y	~~See footnote*~~ Z		See footnote**

~~* It is not permitted to construct a structure with classes of concrete (A, B, C, K, H, DC) and precast concrete members when the risk of ASR is Level 3. Measures must be taken to reduce the level of risk in these circumstances by selecting the aggregates only from the Reactivity Classes of R0, R1 or R2.~~

** It is not permitted to construct prestressed concrete members (Section 603) with Aggregate Reactivity Class of ~~R2 and~~ R3. Measures must be taken to reduce the level of risk in these circumstances by selecting the aggregates only from the Reactivity Classes of R0, ~~or~~ R1, or R2.

601.3.1.1.1.4-Requirements for Various Prevention Levels: These requirements shall apply to all classes of concrete except Class H. The prevention levels for Class H concrete is specified in section 601.3.1.1.1.5.

601.3.1.1.1.4.1-Prevention Level V: No special measures need to be taken for prevention level V.

601.3.1.1.1.4.2-Preventions Level W, X and Y: If it is determined that prevention level W, X, or Y is required, there are two options for prevention as follows:

Option 1: Limiting the Alkali Content of the Concrete: Table 601.3.1.1.1.4.2a prescribes maximum permissible concrete alkali contents in a concrete mix. The alkali content of concrete is calculated on the basis of the alkali contributed by the Portland cement alone.

Table 601.3.1.1.1.4.2a
Maximum Alkali Contents in Portland Cement Concrete to Provide Various Levels of Prevention

Prevention Level	Maximum Alkali Content of Concrete (Na_2Oe)	
	kg/m^3	lb/yd^3
V	No limit	No limit
W	3.0	5.0
X	2.4	4.0
Y	1.80	3.0

Note: The alkali content of the concrete is calculated by multiplying the Portland cement content of the concrete by the alkali content of the Portland cement. The alkali content of all approved cement sources is listed on the WVDOH list of Certified Portland Cement Mills. For example, for concrete containing 550 lb/yd^3 of Portland cement, which has an alkali content of 0.82 percent Na_2Oe, the alkali content of the concrete is 550 X 0.82/100 = 4.51 lb/yd^3 Na_2Oe. SCMs also contain alkalis; however, the use of SCM usually increases the amount of alkalis bound by the hydrates and thus reduces the available alkali content in the concrete. Thus, the alkalis present in SCMs do not need to be considered when calculating the alkali content of the concrete. However, the alkali content of the SCM shall not exceed the limits given in Table 601.3.1.1.1.4.2b. The alkali content of all approved SCM source is listed on the WVDOH approved list of SCMs.

Option 2: Using Minimum Supplementary Cementitious Materials (SCM) based on Level of Prevention. Utilize a minimum mass replacement level from Table 601.3.1.1.1.4.2b below.

Table 601.3.1.1.1.4.2b
Minimum Replacement Level of SCM (percentage by mass of cementitious material)

Type of SCM	Alkali Content of SCM* (Na_2Oe)	Level W	Level X	Level Y
Fly ash** (Cao ≤18%)	≤3.0	15	20	25****
	>3.0, ≤4.5	20	25****	Not Allowed
Slag Cement	≤1.0	25	35	50
Silica Fume***	≤1.0	1.2 x LBA or 2.0 x KGA	1.5 x LBA or 2.5 x KGA	1.8 x LBA or 3.0 x KGA

* The alkali content of all approved SCM sources is listed on the WVDOH approved list of SCMs (APL). If the alkali content of an SCM source is not listed on the APL, the Division will test the SCM from the source to determine the alkali content prior to its use on any WVDOH project.

** The CaO content of approved fly ash sources is listed on the WVDOH approved list of fly ash (APL). If the CaO content of a fly ash source is not listed on the APL, the Division will test the fly ash from the source to determine the CaO content prior to its use on any WVDOH project.

*** The minimum level of silica fume (as a percentage by mass of cementitious material) is calculated on the basis of the alkali (Na_2Oe) content of the concrete contributed by the Portland cement and expressed in lb/yd³ (LBA in Table 601.3.1.1.1.4.2b). LBA is calculated by multiplying the cement content of the concrete in lb/yd³ by the alkali content of cement divided by 100. For example, for a concrete containing 500 lb/yd³ of cement with an equivalent alkali content of 0.81 percent of Na_2Oe, the value of LBA = 500 x 0.81/100 = 4.05 lb/yd³. For this concrete, the minimum replacement level of silica fume for Level Y is 1.8 x 4.05 = 7.3 percent. Regardless of the calculated value, the minimum level of silica fume shall not be less than 7 percent when it is only method of prevention. Mix design with silica fume > 8% shall be reviewed and approved by Engineer.

**** Mix designs with minimum 25% of fly ash shall be reviewed and approved by Engineer.

Notes:

1. The minimum replacement levels in Table 601.3.1.1.1.4.2b are appropriate for use with Portland cements of moderate to high alkali contents (0.71 to 1.00 percent Na_2Oe). Table 601.3.1.1.1.4.2c provides recommendations for adjusting the level of SCM when the equivalent alkali content of the Portland cement is above or below this range. The

replacement levels should not be below those given in Table 601.3.1.1.1.4.2b for prevention level W, regardless of the equivalent alkali content of the Portland cement.

Table 601.3.1.1.1.4.2c
Adjusting the Minimum Level of SCM Based on the Alkali Content of the Portland Cement

Alkali Content (Na_2Oe)*	Level of SCM
≤0.70	Reduce the minimum amount of SCM required in Table 601.3.1.1.1.4.2b by one prevention level.*
>0.70, ≤1.00	Use the minimum levels of SCM required in Table 601.3.1.1.1.4.2b
>1.00, ≤1.25	Increase the minimum amount of SCM required in 601.3.1.1.1.4.2b by one prevention level.
>1.25	Not permitted to be used in PCC

* The alkali content of all approved cement sources is listed on the WVDOH list of Certified Portland Cement Mills (APL). If the alkali content of a cement source is not listed on the APL, the Division will test the cement from the source to evaluate alkali content prior to its use on any WVDOH project.

** The SCM replacement levels should not be below those required in Table 601.3.1.1.1.4.2b for prevention level W, regardless of the equivalent alkali content of the Portland cement.

601.3.1.1.1.4.3-Prevention Level Z: If it is determined that prevention level Z is required, limit the maximum alkali content of concrete to ≤ 3.0 lb/yd^3 (1.8 kg/m^3) plus use the minimum SCM replacement level shown for level Y in Table 601.3.1.1.1.4.2b.

The mix design for Prevention Level Z shall be reviewed and approved by the Engineer.

601.3.1.1.1.5-Requirements for Various Prevention Levels for Class H Concrete:

601.3.1.1.1.5.1-Prevention Level V: No special measures need to be taken for prevention level V.

601.3.1.1.1.5.~~1~~2-Prevention Level ~~V~~X : The contractor may choose Option 1 or Option 2 from Table 601.3.1C. The alkali content of cement shall not exceed 1.25%. The alkali level of fly ash shall not exceed 4.5% in option 1. The CaO of the fly ash must be limited to a maximum of 18% in option 1. The alkali level of slag cement shall not exceed 1.00% in option 2.

601.3.1.1.1.5.~~2~~3-Prevention Level Y:

The contractor may choose Option 1 or Option 2 from Table 601.3.1C if the alkali content of cement does not exceed 1.00% ~~and the alkali level of fly ash does not exceed 3.00%~~. ~~The contractor may also choose Option 1 from Table 601.3.1C if the alkali content of cement does not exceed 0.70% and the alkali level of fly ash does not exceed 4.5%.~~ The alkali level of fly ash shall not exceed 4.5% in option 1. The CaO of the fly ash must be limited to a maximum of 18% in option 1. The alkali level of slag cement shall not exceed 1.00% in option 2.

~~The contractor may choose Option 2 from Table 601.3.1C if the alkali content of cement does not exceed 0.70%. The alkali level of slag cement shall not exceed 1.00%.~~

601.3.1.1.1.5.~~3~~4-Prevention Level Z:

~~The contractor may choose Option 1 from Table 601.3.1C if the alkali content of the concrete does not exceed 3.0 lb/yd³ (1.8 kg/m³). See the note in Table 601.3.1.1.1.4.2a for calculating the alkali content of the concrete. The alkali content of the fly ash shall not exceed 3.00%. The CaO of the fly ash must be limited to a maximum of 18%.~~

~~The contractor may not choose Option 2 from Table 601.3.1C for Prevention Level Z.~~

The contractor may choose Option 1 from Table 601.3.1C if the alkali content of cement does not exceed 1.00% and the alkali level of fly ash does not exceed 3.00%. The contractor may also choose Option 1 from Table 601.3.1C if the alkali content of cement does not exceed 0.85% and the alkali level of fly ash does not exceed 4.5%. The CaO of the fly ash must be limited to a maximum of 18%.

The contractor may choose Option 2 from Table 601.3.1C if the alkali content of cement does not exceed 0.85%. The alkali level of slag cement shall not exceed 1.00%.